J. H. HALL.

CONTROL SYSTEM FOR ELECTROMAGNETS.

APPLICATION FILED MAY 13, 1910.

967,186. Patented Aug. 16, 1910.

3 SHEETS—SHEET 1.

FIG. 2

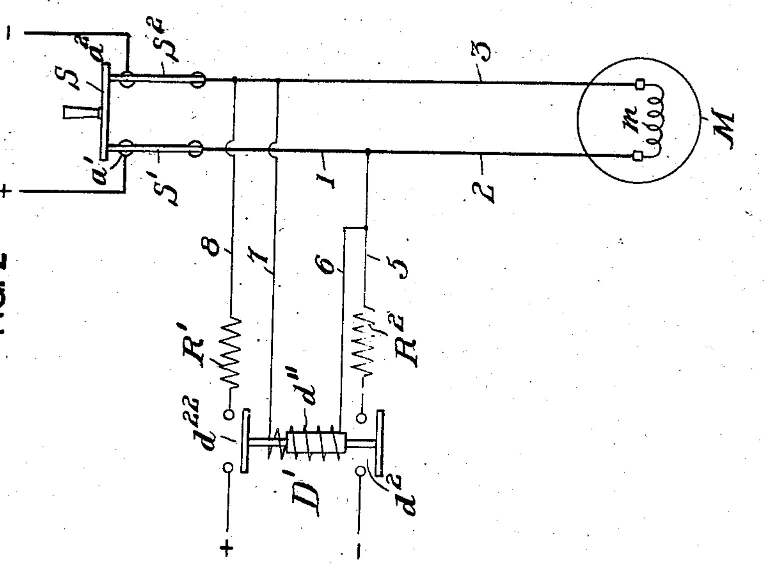
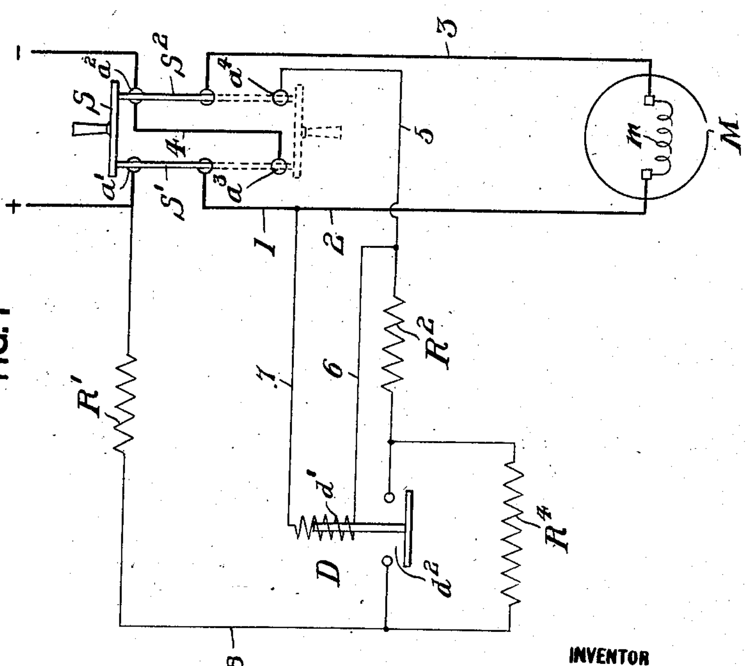


FIG. 1



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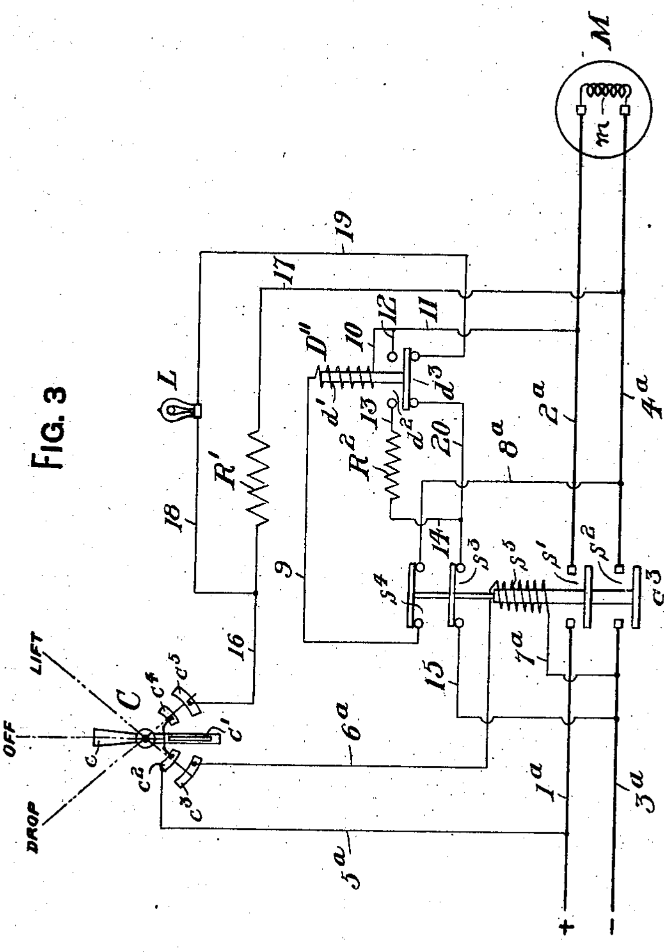
3 SHEETS—SHEET 2.

FIG. 3



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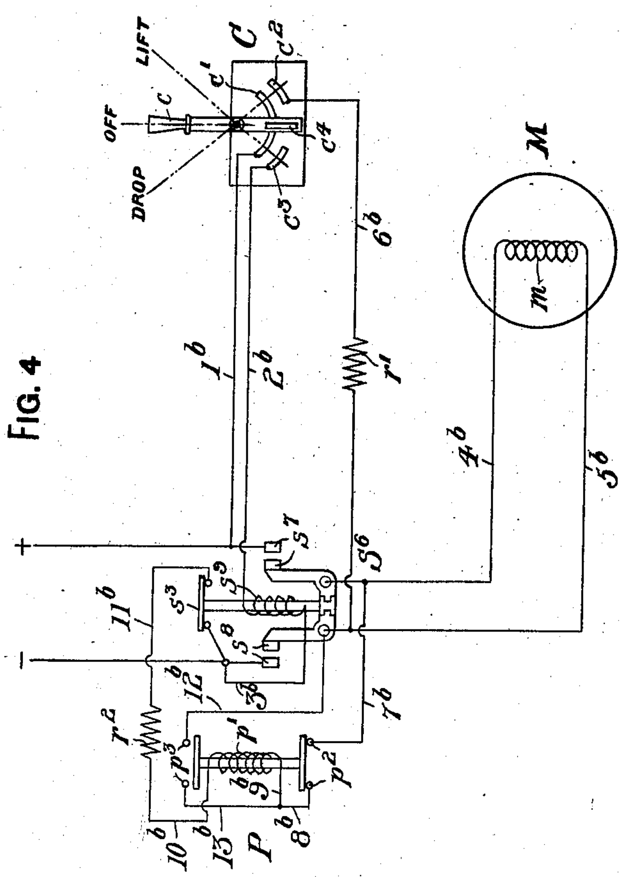
3 SHEETS—SHEET 3.

FIG. 4



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CONTROL SYSTEM FOR ELECTROMAGNETS.

967,186. Specification of Letters Patent. Patented Aug. 16, 1910.

Application filed May 13, 1910. Serial No. 561,100.

To all whom it may concern:

Be it known that I, JAY H. HALL, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented new and useful Improvements in Control Systems for Electromagnets, of which the following is a specification.

My invention relates to systems of control for electro-magnets and has particular reference to that type of electro-magnets known as lifting magnets.

In the use of large lifting magnets it has been found that, owing to the time required for them to become de-magnetized, they do not drop their loads for some time after the magnetizing current has been cut off. In order to cause the magnets to release their loads more quickly, a limited amount of current has been put through their windings in the direction opposite that during the energization of the windings. Heretofore, when loads, such as layers of billets or rails, are being moved and arranged in piles the operator, in lowering the loads and releasing the same by moving the master-switch to the drop-position, sometimes fails to move the master-switch to the off-position before hoisting the magnet from the pile. The small amount of magnetism produced by the reverse current may cause one or more billets or rails to be lifted from the pile, which requires time to put it in shape again.

It is the principal object of this invention to overcome this trouble, so that the reverse current cannot remain in the magnet after the load has dropped, irrespective of whether the operator moves his master-switch to the off-position or not.

Referring to the accompanying drawings, Figures 1, 2, 3, and 4 are diagrammatic views showing four of the many forms which my invention may take.

On Fig. 1, S is a double-throw, double-pole knife switch having the blades S′ and S^2 pivoted so as to engage the contacts a' and a^2, or the contacts a^3 and a^4. The fixed supports for the blades S′ and S^2 are connected to the winding *m* of the lifting magnet M by the wires 1, 2, and 3.

D is a relay having its winding d' connected by the wires 5 and 6 to the contact a^4 and by the wire 7 to the wire 1. The fixed contacts of the relay D are connected to the wires 8 and 5, which include the resistances R′ and R^2, respectively. The contacts a^2 and a^3 are connected by the wire 4. The supply circuit is connected to the contacts a' and a^2.

To energize the magnet M, the switch S is thrown to the up-position shown in full lines and the circuit is established from the positive through the switch blade S′, the wires 1 and 2, the magnet coil *m*, the wire 3, and the switch blade S^2 to the negative. To merely open the circuit the switch S is opened; but to cause the load which has been lifted by the magnet to drop quickly, a reverse current limited by the resistances R′ and R^2 is allowed to flow in the magnet by throwing the switch S to the down-position shown in dotted lines. The discharge voltage from the magnet due to the current dying out in the same is in a direction to cause the current to continue to flow in the same direction through the magnet as when it was energized, and this circuit is from one terminal of the magnet through the wire 3, the blade S^2, the wires 5 and 6, the operating solenoid d' of the relay D, and the wires 7 and 2 to the other terminal of the magnet. The current in this circuit causes the relay D to close its contacts d^2, and a circuit is established as follows: from the positive through the resistance R′, the wire 8, the contacts d^2, the resistance R^2, the wire 5, the switch blade S^2, the wire 3, the magnet coil *m*, the wires 2 and 1, the switch blade S′, and the wire 4 to the negative. It will be noticed that this current passes through the magnet coil in a direction reverse to that when the magnet is energized directly from the line, and is limited by the resistances R′ and R^2. This limiting current can be made large enough to cause the load to drop even before it has reached its full value, and thereby greatly decrease the length of time for the magnet to drop its load after the switch S has been placed in the down-position. The operating winding d' continues to hold the contacts d^2 closed until the discharge voltage of the magnet becomes less and less due to the current through the magnet approaching a constant value, and the relay D may be adjusted so that it will drop open at a voltage corresponding to the voltage existing across the terminals of the magnet at the time the load is released from the magnet.

I have shown the high resistance R^4 connected across the fixed contacts of the relay D. This resistance remains in the reverse-current circuit when the relay contacts are opened. The resistance R^4 may be omitted and I have not shown it in Figs. 2 to 4, but they may contain them, if desired. I prefer to omit the resistance R^4, but have illustrated it to show that it is not absolutely essential to open the reverse-current circuit.

Referring now to Fig. 2, the parts are designated by the same reference characters as similar parts on Fig. 1. The switch S coöperates with the contacts a' and a^2 only, the contacts a^3 and a^4 of Fig. 1 not being required. The relay D′ has the additional contacts d^{22} inserted between the resistance R′ and one side of the line, and the contacts d^2 between the resistance R^2 and the other side of the line. The solenoid winding d'' is so designed that it will not cause the contacts d^2 and d^{22} to close when the voltage of the supply mains is applied thereto, but so that it will close them when subjected to the high inductive discharge voltage of the magnet M. The operation then is as follows: To energize the magnet for attracting its load, the switch S is closed. When it is desired to drop the load the switch S is opened whereupon the high inductive discharge voltage of the magnet causes the relay D to close its contacts, and a circuit is established through the contacts d^2 and d^{22} and the resistances R′ and R^2 through the magnet winding m in a direction opposite to that when it was energized by closing the switch S. This current continues to rise until the voltage has fallen to a point where the relay D opens its contacts, at which time the reverse current will be cut off.

Referring now to Fig. 3, I show another form of my invention, in which a magnetically operated switch S^3 is used in place of the hand-operated switch S shown in Figs. 1 and 2. When it is desired to energize the magnet M, the arm c of the master-switch C is moved from the off-position to the position marked "Lift", where the brush c' connects the segments c^2 and c^3. A circuit is then established from the positive through the wire 5^a, the segment c^2, the brush c', the segment c^3, the wire 6^a, the operating solenoid s^5 of the switch S^3, and the wires 7^a and 3^a to the negative. The current in this circuit causes the switch S^3 to close its contacts s' and s^2 and open its contacts s^3 and s^4. The circuit through the magnet is now from positive through the wire 1^a, the contacts s', the wire 2^a, the winding m of the magnet M, the wire 4^a, the contacts s^2, and the wire 3^a to the negative. The magnet by means of a suitable crane can now lift its load and convey it to any desired place, where the magnet is lowered until the rails rest upon the support, on which it is desired to place them. If it is now desired to release the rails quickly, the controller arm c is thrown to the position "Drop", at which time its brush c' connects the segments c^4 and c^5. As soon as the brush c' leaves the segments c^2 and c^3 the switch S^3 opens its contacts s' and s^2, cutting off the current from the magnet, and the contacts s^3 and s^4 close. The discharge voltage from the magnet now causes the operating solenoid d' of the relay D′′ to be energized through the following circuit: from one terminal of the magnet M through the wires 4^a and 8^a, the contacts s^4, the wire 9, the solenoid d', and the wires 10, 11, and 2^a to the other terminal of the magnet. The current in this circuit causes the relay to close its contacts d^2 and the reverse current circuit is established from the positive through the wire 5^a, the segments c^2 and c^4, the brush c', the segment c^5, the wire 16, the resistance R′, the wires 17 and 4^a, the magnet winding m, the wires 2^a, 11, and 12, the contacts d^2, the wire 13, the resistance R^2, the wire 14, the contacts s^3, and the wires 15 and 3^a to the negative. The reverse current circuit being now established continues to flow until the magnetism is reversed in the magnet, allowing the load to drop, at which time the relay causes its contacts d^2 to open, the relay D′′ having been adjusted to open these contacts at a time shortly after the load would be released. The magnet can now be raised off the rails without any danger of carrying the rails with it or in any way disturbing the pile on which they have been deposited.

A signal lamp is shown at L, which is connected to the contacts d^3 of the relay D′′ which are closed whenever the contacts d^2 are open. One terminal of this signal lamp is connected to the segment c^5 through the wires 18 and 16, and to the negative side of the source of supply through the wire 20, the contacts s^3, and the wires 15 and 3^a. Whenever the master controller arm c is in the position marked "Drop", and the reverse current has reached such a point that the load will be dropped, the lamp F will be lighted to notify the operator that he can move the magnet safely without disturbing the load which he has just deposited.

Referring to Fig. 4, S^6 is a magnetic switch which causes current to be supplied to the winding m of the magnet M to fully magnetize it when the master switch is in the "Lift" position. When the master switch is in the "Drop" position current passes through the magnet in the reverse direction, limited by the resistances r' and r^2, causing the magnetism to be reversed, allowing the load to drop quickly. The switch P is controlled by the reverse current and is arranged to operate when the reverse current reaches its maximum or nearly so. When the switch P operates, it cuts off the reverse current from the magnet and establishes a holding circuit to hold the switch in the operative position so long as the master switch remains in the "Drop" position.

The operation is as follows: When the master switch handle c is moved to position marked "Lift," a circuit is established through the magnetizing winding s^9 of the switch S^6 from the positive through the wire 1^b, the contact c', the finger c^4, the contact c^3, the wire 2^b, the winding s^9, and the wire 3^b to the negative. This causes the switch S^6 to close its contacts s^7 and s^8, and the magnet M is energized by the current from the positive through the contacts s^7, the wire 4^b, the magnet winding m, the wire 5^b, and the contacts s^8 to the negative. The magnet is now fully energized and will pick up its load.

When it is desired to release the load the master handle c is moved to the position marked "Drop," whereupon the switch S^6 opens its contacts s^7 and s^8, the winding s^9 being deënergized as soon as the finger c^4 leaves the contact c^3. A new circuit is established through the magnet winding m in a reverse direction as follows: from the positive through the wire 1^b, the contact c', the finger c^4, the contact c^2, the wire 6^b, the resistance r', the wire 5^b, the magnet winding m, the wires 4^b and 7^b, the contacts p^2, the wires 8^b and 9^b, the magnetizing winding p', the wire 10^b, the resistance r^2, the wire 11^b, and the contact s^8 to the negative. The magnetism due to this reverse current passes through zero and the load is released. When the reverse current reaches a maximum or nearly so, the winding p' causes the switch P to operate, closing the contacts p^3, and opening the contacts p^2. The opening of the contacts p^2 cuts off the reverse current from the magnet. This current being small, because limited by the resistances r' and r^2, the magnet is immediately de-magnetized on cutting off the reverse current, and should the operator hoist the magnet with the master handle in position marked "Drop," no part of the load would be lifted.

The closure of the contact p^3 establishes a holding circuit from the positive through the wire 1^b, the contact c', the finger c^4, the contact c^2, the wire 6^b, the resistance r', the wire 12^b, the contacts p^3, the wires 13^b and 9^b, the winding p', the wire 10^b, the resistance r^2, the wire 11^b, and the contacts s^8 to the negative. The current in this circuit holds the switch P in a position to keep the contacts p^2 open as long as the master-switch handle c' is in the position, marked "Drop," and after the reverse current has reached a value sufficient to drop the load. On moving the handle c' to the "Off" position the switch winding p' is deënergized, and the switch P is restored to its normal position.

The magnet M can be deënergized when fully excited by moving the master handle from the lift-position to the off-position, but the magnet will be slow in becoming demagnetized, and the load will take some time to release.

As shown in Fig. 1 the current in the reverse-current circuit is, upon the opening of the contacts d^2, cut down by the resistance R^4 to such a value as to prevent the flow of a current which would cause the magnet when lifted to raise any part of the load which it deposits.

In Figs. 2 to 4, the resistance R^4 though omitted may be regarded as having its place supplied by the gap at the contacts d^2 where the resistance has reached its maximum, that is, an infinite value.

I claim—

1. A magnet having an energizing winding, switch-mechanism, and connections constructed and arranged to cause energizing currents to flow successively through the winding in opposite directions and to interrupt the second energizing current when it reaches a predetermined value.

2. A magnet having an energizing winding, switch-mechanism, connections constructed and arranged to cause energizing currents to flow successively through the winding in opposite directions and to interrupt the second energizing current when it reaches a predetermined value, and means to limit the value of the second energizing current.

3. A magnet having an energizing winding, switch-mechanism, and connections constructed and arranged to cause energizing current to flow successively through the winding in opposite directions, the switch-mechanism containing a winding controlled by the discharge voltage of the magnet winding and controlling contacts which interrupt the reverse current when it reaches a predetermined value.

4. In a controller for electro-magnets, the combination of switches for reversing the connection of the magnet winding to the supply mains, a resistance for limiting the flow of current in one direction, and means for automatically interrupting the said current from the magnet when the said current has reached a certain value.

5. In a controller for lifting-magnets, the combination of a magnetically operated switch for connecting the winding of the magnet to the supply mains, a master switch, having contacts for energizing the winding of said magnetically operated switch, and contacts for closing the circuit of the winding of said magnet to give a reverse direction of current flow through said winding, and means for causing said reverse current to be interrupted after it has reached a certain value.

6. In a lifting-magnet controller, the combination of a magnetically-operated switch having main contacts which connect the magnet winding to a source of energy, and having auxiliary contacts arranged to close when the main contacts are open and to open when the main contacts are closed, a master switch having contacts arranged to connect the winding of said magnetically-operated switch to a source of supply, and also to connect the winding of the magnet to the source of supply so that the current will flow through the winding in a direction opposite to that in the first connection, said circuit containing the said auxiliary contacts, and means for automatically opening the circuit of said magnet winding when the current reaches a certain value.

7. For reversing the current through a lifting magnet to cause it to release its load, an electro-magnet having its operating winding connected to the magnet terminals and responsive to the high discharge voltage of the magnet when its circuit is opened, a switch operable by the said winding to close a circuit through the lifting magnet in a direction opposite to that previously existing therein.

8. An inductive winding, means for connecting said winding to a source of supply to pass current through said winding in one direction, and a second means responsive to the discharge voltage of the said winding for connecting the said winding to a source of supply to pass current through said winding in a reverse direction.

9. An inductive winding, means for connecting said winding to a source of supply to pass current through said winding in one direction, a second means responsive to the discharge voltage of the said winding for connecting the said winding to a source of supply to pass current through said winding in a reverse direction, and constructed and arranged to automatically cut off said reverse current when it has reached a certain value.

10. The method of controlling lifting-magnets containing energizing windings, which consists of connecting the magnet winding to a source of supply to energize it for attracting a load, disconnecting it from the said source and reconnecting it to the source of supply so that the current flows in a reverse direction through the magnet winding to cause the load to be released, and automatically interrupting the reverse current at or near the time that the load is released.

Signed at Cleveland, Ohio, this 11th day of May, A. D. 1910.

JAY H. HALL.

Witnesses:
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H. M. DIEMER.